vations which in his opinion demonstrate that in the chain of the Jura, the east of the Paris basin, and in Portugal the lower part and even the whole of the Callovian are locally replaced by an extension of the Bathonian deposits.—(*Jornal de Sciencias Mathematicas*, &c., Lisboa, No. xxxvii., 1884.)

THE GLACIAL BOUNDARY IN OHIO.—Prof. G. F. Wright has for ten years past been studying the glacial phenomena of the Eastern States of the Union. Beginning with the kames of the Merrimac Valley in Eastern Massachusetts, he has followed the last edge of the glacial trail from the Atlantic border across to the southern part of Illinois. How much further he may have to trace it westwards he is at a loss to know. Meanwhile he gives an interesting outline of his labours in a pamphlet just issued by the Western Reserve Historical Society of Cleveland, Ohio. The edge of the deposits left by the ice-sheet of the Glacial Period or "terminal moraine," as the American geologists call it, has been traced by him from the western part of Pennsylvania across the southern counties of Ohio and the northern margin of Kentucky to near the Miami and Ohio Rivers. It then enters Indiana and makes a great northward sweep as far as Martinsville, a little south of Indianapolis, whence it turns south-westwards and passes into Illinois a little above the confluence of the Wabash with the Ohio. The Report gives detailed maps of the "moraine" in its passage across Ohio, with descriptions of the nature and form of the drift ridges in the different counties and townships.

HYPERSTHENE-ANDESITE AND TRICLINIC PYROXENE IN AUGITIC ROCKS.—The United States Geological Survey has begun the issue of a *Bulletin* designed to appear from time to time in single parts, each containing a single paper complete in itself. These papers are to be such as relate to the general work of the Survey, but do not properly come within the scope of the Annual Reports or Monographs. The first number is devoted to the rocks of Buffalo Peaks, Colorado. A sketch of their geology by Mr. Emmons, the geologist in charge of the Rocky Mountain Division of the Survey, is followed by a detailed description of some volcanic masses by Mr. Whitman Cross, in which he continues his interesting researches on pyroxenic rocks. As fragments among the beds of tuff and likewise in place on the shoulder of the main Buffalo Peak, there occur certain augite-andesites the microscopic study of which reveals some important peculiarities. The pyroxenic constituent shows that a rhombic mineral, probably hypersthene, is largely predominant, while a great number, if not all, of the remaining crystals must be considered as triclinic. The occurrence of triclinic pyroxene had already been detected by the author among the crystalline schists of Brittany. He has been led to re-examine many pyroxenic rocks (diabase, melaphyre, basalt, &c.) from widely separated localities, with the result of finding, in some common rocks from well-known localities, that the augite, when placed between crossed Nicol prisms, is extinguished at a very decided angle from the diagonals of the prism. This abnormal action he thinks must show either that the mineral in question is triclinic or that there is an "optical anomaly." Following the example of Fouqué, who isolated and analysed the normal augite and unsuspected hypersthene of the Santorin andesite, Mr. Cross isolated the rhombic pyroxene of the rock of Buffalo Peaks, and proved its crystalline form by examining detached crystals under the microscope. He likewise submitted it to chemical determination, which proved it to be true hypersthene. These researches induced him to test the character of the pyroxenic constituent in other andesites from all parts of the world. He has found that a rhombic pyroxene is much more abundant in porphyritic crystals than augite. He suggests the need of a reclassification of andesite rocks, of which he thinks three main groups may be distinguished. At one extreme are the varieties with a trachytic character rich in felspar, often containing quartz or tridymite, and with a more crystalline ground-mass. At the other extreme are some basalt-like masses, but with little or no olivine. The normal "augite-andesites" form the intermediate group.

KRAKATOA AND THE SUN-GLOWS

IN the last issue of the *Bulletin of the St. Petersburg Academy of Sciences* (vol. xxix. No. 2), M. Rykatcheff publishes a very interesting paper on the atmospheric waves produced by the Krakatoa eruption. General Strachey and Mr. R. H. Scott (NATURE, vol. xxix. p. 181) have already shown how the eruption must have produced an atmospheric wave which has been noticed by the barometers at many meteorological observatories. The wave was propagated in concentric circles, increasing in diameter until it reached the great circle; then, it contracted until reaching a point on the antipode of Krakatoa, whence the wave returned in the same way to its point of origin; then, gradually diminishing in intensity, it made for a second and third time its way around the earth. M. Rykatcheff now publishes the curve of the barograph of Pavlovsk for August 27 to 30, where the influence of the atmospheric wave is pretty well seen; and he discusses the results obtained from observations at thirty-one different stations (Pavlovsk, St. Petersburg, Berlin, Leipzig, Magdeburg, Brussels, Paris (I. and II.), Toulouse, Greenwich, Kew, Aberdeen, Stonyhurst, Liverpool, Glasgow, Falmouth, Armagh, Valentia, Georgia Island, Coimbra, and Toronto). It appears from these observations, when calculated according to Gen. Strachey's method, that is, by taking the time between two successive passages of the wave at the same station, that, for European stations, on the average the wave took 36h. 38m. to make its way around the earth when it was going from east to west, and 35h. 54m. when going from west to east. The accordance of the figures for different observatories is striking (excepting Tolosa), the greatest deviation from the average being only + 33m. and − 38m. in the first case, + 27m. and − 39m. in the second. The average speed would thus be: for the first wave, 303·3 metres, and 316·1 metres for the second. The calculated time of the Krakatoa eruption would be between 9h. 6m. and 9h. 42m. Krakatoa mean time; or, on the average, 9h. 23m. When the calculations are made on M. Wolf's method (which admits the same speed in both directions), the average speed of the wave is 334·3 metres, and the time of the eruption would be 10h. 39m. Krakatoa mean time. Finally, M. Rykatcheff makes the calculations by deducing both speed and time of eruption from observations made at two stations next to Krakatoa (Pavlovsk and St. Petersburg), and then he calculates from equations made for all other stations the error of the two observations. He receives thus 321·4 metres for the speed of the wave, and 10h. 16m. for the time of the eruption at Krakatoa. These results are more in accordance, he says, with the result obtained by Herr Wolf's method, and, combining both, M. Rykatcheff takes as probable 327·9 metres for the speed, and 10h. 27m. for the time of the eruption. As to the amplitudes of the oscillations of the barometers at different stations, they vary from 0·9 to 1·7 mm. and reach 2·5 mm. at Georgia Island.

To the *Meteorologische Zeitschrift* for 1884 Dr. G. Hellmann contributes a learned paper on the recent glows. No theory is advanced as to their origin, and the interest of the paper is mainly historical. The oldest reference to similar phenomena the writer has been able to discover is that of the Flemish physician, H. Brucæus, who, in 1570, dedicated a "Tractatus de Crepusculis" to Tycho Brahe. In this work occurs the passage: "Cum autem diluculum initium sumat, ubi aër splendescere incipit, idque eveniat cum lumen solis ab aëre, ob vapores permixtos crassiores, versus horizontem reflectitur, patet non in eadem distantia solis ab horizonte crepuscula semper incidere, quod non una sit semper aëris densioris sive vaporum, a quibus fieri possit radiorum reflexio, altitudo."

In the *Annales de Chimie et de Physique*, sixth series, vol. i. 1884, MM. Perrotin and Thollon deal with the same subject from the physical standpoint. They give an able *résumé* of the various accounts that have appeared, especially in NATURE, and seem on the whole disposed to accept the theory of the volcanic origin of the after-glows.

A correspondent, F. A. R. R., sends us the following communication on the subject:—

The matter projected into the upper atmosphere appears to have passed round the globe westwards with great velocity, and to have diffused itself towards north and south much less rapidly. A stratum of fine dust thus formed itself at an elevation probably exceeding the altitude of the known upper currents. This stratum caused the sun to look green or blue on the Gold Coast, in the West Indies, at the Sandwich Islands, in India and the Indian Ocean, and last, as late as September 24, in the Soudan, nearly a month after the eruption of Krakatoa. The moon and stars were frequently greenish in Europe in December and January, up to four months and a half after the eruption, and the sun whiter than usual towards setting. The finely divided matter which thus deprived the sun and moon of

part of the rays which go to form the compound white, was plainly of a different grain from the small particles commonly present in the sky, for these arrest the blue rays and scatter them, allowing the rays towards the red end of the spectrum a freer passage, so as to impress the eye with the predominant red colour of luminous objects seen through a long stretch of atmosphere. Since the declining sun in India turned strongly green, the particles competent to arrest the red rays must have exceeded, in the path of the rays, the ordinary blue-arresting particles in quantity or power. But as the sun approached close to the horizon, the lower atmosphere, by cutting off the more refrangible rays, reduced the green, and sometimes caused the red to predominate in the setting sun. The particles of a common blue haze cause the sun to set deep red. The volcanic dust particles may have exceeded in magnitude the particles which cause haze, and possibly the stratum may have contained particles which might be visible under the microscope. That this dust stratum was still present in the higher atmosphere in January was indicated by the greenish tinge of moon and stars. It was largely composed of particles of sufficient magnitude to reflect white light, for a little before sunrise the sky seemed clouded over with something resembling white cirrus haze; but like a film of dust on a mirror, or the floating dust in a room, it was not visible except at certain angles. Condensed vapour, or ice particles in a very fine state of division, would account for the persistent halo or corona of varying radius, but so also would particles of transparent pumice. Assuming the red-arresting stratum to have remained during the autumn and winter months at altitudes from forty to twenty miles, descending say 1000 feet per day during 100 days, the effects observed after sunset and before sunrise were only what might be expected to follow by reflection from the minute surfaces. In the case of ordinary cirrus, the tints up to half an hour after sunset are as follows: white, pale yellow, yellow, orange, pink, red, deep red; or the red only may be visible if the texture be thin and the early twilight strong. With a continuous red-arresting stratum, however, we must consider what influence its horizontal breadth, through which the sun's rays must pass when near setting, would have upon the light reflected from the western sky. At a height of thirty miles the sun would be shining through a great length of the stratum, as viewed from the elevated point, when it had already set on the earth immediately below. At this point, thirty miles above the earth's surface, supposing that to be the height of the stratum, the vapour of the lower air would not yet be strongly exerting its influence in arresting the blue rays, but the sheet of dust would exert its maximum power of stopping the red rays, and the light which survived best, and which from the earth's surface we should see reflected soon after sunset from above the western horizon, would be green. The stratum being so composed as to be capable of reflecting all kinds of light, but by its own action through a great breadth filtering out some of the less refrangible rays, as it did more powerfully in India when less attenuated, the reflected light of the sun above the western horizon, and indeed towards north and south as well, could not fail to be affected with an excess of green. As the sun sank still lower, viewed from the height of thirty miles, it would begin to be largely robbed of the blue and green rays by the ordinary lower atmosphere, and the next colour in the western sky would consequently be yellow, which would equally be reflected by the matter composing the stratum. The yellow would be the result of a competition between the red-arresting upper dust and the blue-arresting lower air. As the sun descended still lower, the power of the ordinary vapour-charged strata would assert itself, and the yellow would pass to orange, pink, and crimson, just as the colour of the sun seen from any eminence commonly changes in setting. The upper haze would merely reflect these naturally changing colours, but the later tints would be more striking as darkness increased. All the changes observed in the first after-glow are thus fully accounted for by larger than ordinary sky particles arresting red waves and the general mass of the stratum reflecting all rays falling upon it. The secondary after-glow would show similar gradations if the first were strong enough to emit much light, but the red in it would be most conspicuous, for the action of the lower air in eliminating blue would be more powerful than the thin veil of dust in eliminating red. There was, however, a distinct greening of the eastern sky on several occasions, signifying the approach of the secondary after-glow. The increase of apparent brilliancy of both glows as they sank westwards would of course be due to perspective.

THE FIXED STARS[1]

II.

I HAVE said that the angle between the stars is measured in terms of the scale, but the scale-value, in seconds of arc, may change by the effects of temperature and from other causes.

Bessel, in his researches on the parallax of 61 Cygni, determined by independent means the effect of temperature on his scale-value, and applied corresponding corrections to his observations. But he also took the precaution to employ two stars of comparison situated at right angles to each other with respect to the principal star, so that the effect of parallax would be at a maximum for one comparison star at the season of the year when it was at zero for the other, and *vice versâ.*

But in the course of previous researches I found that there were sources of error other than mere change of the temperature of the air, viz. differences of temperature in different parts of the instrument, and changes in the normal focus of the observer's eye, which exercised a very sensible influence on the results. It was necessary to devise some method by which these should also be eliminated.

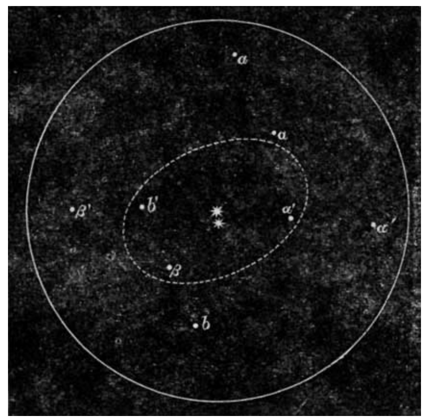

DIAGRAM II.—Showing comparison stars employed in determining the parallax of α Centauri.

There is a very simple means of doing this. Instead of taking two comparison stars at right angles, take two comparison stars situated nearly symmetrically on opposite sides of the star whose parallax is to be determined—such, for example, as the stars α and β in Diagram II. Now observe these distances in the order α, β, β, α, on each night of observation; so that on each night the observations of both distances are practically made at the same instant. Then, whatever causes have combined to create a systematic error in the measurement of one of these distances, precisely the same causes must create precisely similar systematic error in the measurement of the other distance. Thus if, by the regular or irregular effects of temperature or by changes in the normal condition of the observer's eye, we measure the distance α too great, so for the simultaneous observations of the distance β we shall from precisely the same causes measure that distance too great also.

But the *difference* of the distances will be entirely free from all errors of the kind; and, if the distances are not quite equal, it is very easy to apply a correction on the assumption that the sum of the distances is a constant.

In Diagram II. the circle represents a radius of 2° surrounding the star α Centauri. The distance of the component stars α_1 and α_2 Centauri in the diagram is enormously exaggerated for the sake of clearness. Guided by the principles just explained, search was made for comparison stars in pairs symmetrically situated with respect to α Centauri, and otherwise favourably situated for measurement of parallax.

You will remember that from the effects of parallax all stars appear to describe small ellipses about a mean position; stars near the pole of the ecliptic describing nearly circles, and those

[1] Lecture on Friday evening, May 23, at the Royal Institution, "On Recent Researches on the Distances of the Fixed Stars, and on some Future Problems in Sidereal Astronomy," by David Gill, LL.D., F.R.S., Her Majesty's Astronomer at the Cape of Good Hope. Continued from p. 137.